2026

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## NEW INSIGHTS IN EQUINE NUTRITION

DIETS FOR INSULIN-DYSREGULATED HORSES

**FEEDING HORSES WITH ASTHMA**

EFFECTS OF MARE NUTRITION ON OFFSPRING

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***Cover photo: Shelley Paulson***

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HORSE NUTRITION

Hi, I'm Dr. Randel Raub, Equine Research and Nutrition Specialist at Sentinel®. One of the things I've always appreciated about working in equine nutrition is that there's always more to learn. Research continues to give us a better understanding of how nutrition affects the horse, from digestion and metabolism to hydration, respiratory health, and the development of future generations.

Just as importantly, we're learning how to put that science into practice. In this issue, we'll get into the latest research shaping the way we feed and care for horses. We'll look at new findings, revisit familiar nutritional challenges, and discuss how veterinarians, nutritionists, and horse owners can use this growing body of knowledge to make more informed decisions.

In the pages ahead, we'll explore:

- Some of the year's most notable equine nutrition research, including findings related to the microbiome and hindgut health, extruded feeds, amino acids, and fiber-based diets.
- What we're learning about insulin-dysregulated horses and how different feeds and nutrients may influence insulin response.
- The latest findings on nonstructural carbohydrate (NSC) levels in hay and pasture, why those levels can vary, and why forage testing matters.
- How a mare's nutrition can influence the health and development of her offspring.
- Nutritional strategies for horses with asthma, including low-dust forage and feed options, omega-3 supplementation, and emerging research.

At Sentinel, research is more than something we follow. It helps guide how we formulate feeds, evaluate new nutritional approaches, and provide practical recommendations for the horses in our care.

Our goal is to help turn good science into better decisions. Because the more we understand about the horse, the better equipped we are to support their health, performance, and well-being throughout every stage of life.

Randel Raub, PhD
Equine Research and Nutrition Specialist | Sentinel Horse Nutrition

**To learn more, visit the Sentinel Pro Health Hub.**

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# Equine Nutrition Research Roundup

## Bite-sized take-homes on modulating inflammation, the microbiome, and reproductive success through nutrition.

Stacey Oke, DVM, MSc

Attitudes surrounding nutrition have changed drastically over the past several decades. It's now recognized as not just a means of providing energy but a key component of preventing and even treating disease. The scientific literature is peppered with articles exploring various connections between diet and health, disease, and performance. Here, we've summarized a select number of studies relaying the most up-to-date information on the role of fatty acids on inflammation, supporting hindgut health, and micronutrients for reproductive success.

### Short-Chain Fatty Acids, Gut Health, and Inflammation

In a 2025 review article, Schank et al. highlighted the importance of short-chain fatty acids (SCFAs) on gut health and their role as anti-inflammatories to support gut and immune health.

SCFAs not only serve as critical energy sources for horses but also exert diverse metabolic and protective effects both locally within the gastrointestinal tract and systemwide. *Firmicutes* and *Bacteroidetes* predominantly produce SCFAs. In turn, acetate, propionate, and butyrate support the proliferation of fibrolytic microbes and contribute to intestinal health. Butyrate, in particular, plays an important role serving as the primary energy source for colonocytes and, therefore, maintaining intestinal barrier integrity and abrogating leaky gut syndrome.

Relative to inflammation, "SCFAs exert potent anti-inflammatory effects by reducing chemokine production and limiting leukocyte recruitment," Schank et al. wrote. "GPR-41, expressed on neutrophils, monocytes, and adipocytes, is activated by SCFAs and can induce neutrophilic chemotaxis. However, in the presence of other chemoattractants, SCFAs exert the opposite effect by down-regulating receptor expression, thereby suppressing neutrophil migration."

Further, research shows that butyrate inhibits T-cell proliferation, reduces antigen-driven T-lymphocyte expansion, and promotes regulatory T-cell differentiation to collectively suppress excessive immune activation, regulate immune responses, and suppress pro-inflammatory pathways.

**Take-Home Message:** Equine nutrition programs can focus on developing strategies that support hindgut SCFA production and establishing SCFA supplement approaches.

"Such advancements hold substantial promises for reducing the incidence of colic, strengthening gastrointestinal resilience, and ultimately improving equine health, performance, and welfare," the authors wrote.

*Schank N, Cottone A, Wulf M, Seiter K, Thomas B, Miller LMJ, Anderson SL, Sahyoun A, Abidi AH, Kassan M, et al. The Role of Short-Chain Fatty Acids (SCFAs) in Colic and Anti-Inflammatory Pathways in Horses. Animals. 2025; 15(23):3482.*

## Feeding Strategies' Effects on Hindgut Health

The equine intestinal microbiome is home to quadrillions of bacteria, with each gram of feces containing one trillion bacteria. The hindgut is also home to viruses, archaea, protozoa, and fungi. Together, these microbes maintain a healthy environment for fermenting fiber to produce volatile SCFAs. Based on multiple studies, the most common bacteria found in the equine intestinal microbiome include *Firmicutes, Bacteroidetes, Fibrobacterota, Spirochaetes, Acidobacteria*, and *Proteobacteria* (Hart et al. 2026). Forage-based diets are typically associated with rich and diverse microbiomes lush in *Firmicutes* and *Bacteroidetes*. However, many horse owners add concentrated feeds high in starch for reasons such as increasing energy or lack of grazing opportunities.

Complete extruded feeds (CEDs) that are high in fiber might serve as solutions to a lack of pasture availability or limited space for storing hay. Franzan and colleagues from Brazil evaluated the effects that a gradual transition from hay to a CED has on the equine intestinal microbiome. (Note that ingredient composition, including fiber type, can have dramatic effects on the microbial environment, regardless of the type of diet.)

In the study, they fed 12 healthy geldings a coastcross (Bermudagrass hybrid) hay diet at 2.5% body weight for seven days. Starting on Day 8, a CED was introduced to half the horses' diets while the other half remained on the hay-only diet. The hay:CED ratio was adjusted weekly for three weeks from 70:30% to 40:60% and 0:100%. Fecal samples were collected from the hay-fed horses on Days 7 and 28 and the CED-fed horses on Days 7, 14, 21, and 28.

Data analysis revealed the following:

- Horses fed CED had lower diversity than horses fed exclusively hay but only once the CED completely replaced hay (0:100%) and not at the lower ratios of hay:CED. "Hay seems to be required for maintenance of microbial diversity, because the alpha diversity indices remained stable during partial hay inclusion (Days 7-21), but decreased sharply once hay was removed (Day 28). This indicates that the loss of roughage, rather than [non-fiber carbohydrates] increased per se, was the main driver of reduced community stability," the researchers wrote.
- After feeding hay exclusively for 28 days, fecal bacterial communities between the two groups diverged. "Horses fed exclusively hay maintained a relatively uniform microbial community, which differed from those observed in animals receiving any level of CED," said Franzan et al.

Specifically, the research team found that CED intake reduced the relative abundance of *Fibrobacteres* and *Proteobacteria*, among others, while increasing *Verrucomicrobia* and *Synergistetes*. These changes suggest a decreased fermentative capacity associated with the CED diet.

The study authors also suggested that evaluating fecal bacterial diversity could help develop dietary adaptation programs and transition schedules to avoid abrupt changes in feeding. Previous work by this research group showed that a sudden change from hay to CED rapidly reduces bacterial diversity and hindgut pH (Franzan et al. 2022). Currently, some experts recommend increasing concentrates by 0.2 to 0.3 kg/day to allow sufficient time for adaptation to a higher-starch diet; however, the National Research Council (2007) notes that this recommendation is not based on experimental studies.

In another microbiome study, Hart et al. evaluated a commercial fiber-based feed's effects on the equine hindgut. The study involved two groups of horses: One was offered a forage-based diet and the other a combination of forage and concentrate. The researchers used an in vitro fermentation vessel and fecal samples collected from the horses following each diet trial to assess the effect of a commercial fiber-based feed on the microbiome of these two groups of horses.

At baseline, the forage-fed horses had higher *Firmicutes, Fibrobacterota*, and *Acidobacteria* compared to horses fed the mixed forage/concentrate diet, whereas the horses fed the mixed diet had higher *Bacteroidetes*. Higher diversity was observed in forage-fed horses. This confirmed previous findings that forage-fed horses have a more stable microbiome than horses fed a traditional mixed ration. After they incorporated the fiber feed, the researchers did not observe any effects on the microbiome in forage-fed horses except that incorporating the fiber feed into the mixed ration temporarily resulted in a microbiome that was more consistent with forage-fed horses.

**Take-Home Message:** Equine fecal bacterial communities are strongly influenced by both diet composition and adaptation time, with microbial diversity appearing more closely linked to roughage intake than feed. Veterinarians should emphasize gradual dietary transitions to allow hindgut microbial communities to adapt, and fecal bacterial diversity might offer a useful indicator for evaluating or optimizing dietary adaptation periods.

*Franzan BC, da Silva Coelho I, Ramos EM, de Souza ARP, de Almeida FQ, Silva VP. Complete Extruded Diet: How Does Equine Fecal Microbiota Change During Intake Adaptation? Anim Sci J. 2026 Jan-Dec;97(1):e70147.*

*Hart KJ, Hegarty MJ, Hart EH. An investigation into the impact of the inclusion of a commercial fiber-based feed, designed for both hydration and nutrition, on the equine hindgut microbiomes. J Equine Vet Sci. 2026 Jun;161:105862.*

## Supplementation's Effects on Embryo Recovery and Ovarian Response

Recognizing the importance of

optimal nutrition for successful reproductive performance, including follicular growth, ovulation, luteal function, and early embryonic development, Camargo et al. evaluated the effect of a multinutrient supplement containing vitamins, minerals, folic acid, select amino acids, and fatty acids on embryo recovery and ovarian responsiveness in donor mares. They hypothesized that manipulating ovarian responsiveness in embryo transfer programs might improve reproductive outcomes.

In the reproductive setting, research shows:

- Vitamins A, E, and B-complex play roles in redox (oxidation) balance and energy balance, relevant to oocyte competence and early embryo viability.
- Beta-carotene is believed to accumulate in ovarian tissue and might affect luteal function and progesterone synthesis.
- Trace minerals including chromium, copper, zinc, and selenium modulate ovarian activity, as they are co-factors in metabolic and antioxidant systems.
- The micronutrients manganese, iodine, and phosphorus support follicular development and oocyte maturation.
- Polyunsaturated fatty acids, as precursors to eicosanoids, modulate inflammation and uterine function, potentially decreasing post-breeding inflammation.
- Amino acids play various roles in metabolic pathways such as supporting uterine perfusion and luteal function.

Nutrition might also "directly modify the follicular microenvironment and the oocyte, which ultimately determines developmental competence," the study authors wrote.

The study involved 12 mares maintained on pasture. Their basal diets were identical and included ad libitum access to pasture, Tifton hay, mineral salt, and water. A commercial concentrate was also offered to all mares. Half of the mares were randomly selected to receive a commercial multinutrient supplement at a rate of 40 g/day for 150 days.

All mares were observed for signs of estrus and evaluated with transrectal ultrasound until a dominant follicle measuring ≥ 35 mm was identified in conjunction with uterine edema, relaxed cervix, and soft uterus. The researchers then induced ovulation with an intramuscular injection of histrelin acetate and artificially inseminated the mares with frozen semen 24 hours following ovulation induction. Eight days after ovulation, they performed embryo recovery and graded the embryos using standard procedures. One hundred and fifteen flushes were ultimately performed over two breeding seasons.



BIANCA MCCARTY

**The embryo recovery rate was higher in the supplemented mares than in the control group.**

The key finding of this study was that the embryo recovery rate was higher in the supplemented mares (81.7%) than in the control group (65.4%). Follicular activity also increased when mares were offered the nutritional supplement, and no differences in embryo morphology were identified between supplemented and unsupplemented mares.

"This gain [in embryo recovery rate] is biologically and operationally meaningful for equine embryo transfer programs because even incremental improvements in recovery translate into more embryos per breeding season and better efficiency per uterine flush," the authors wrote.

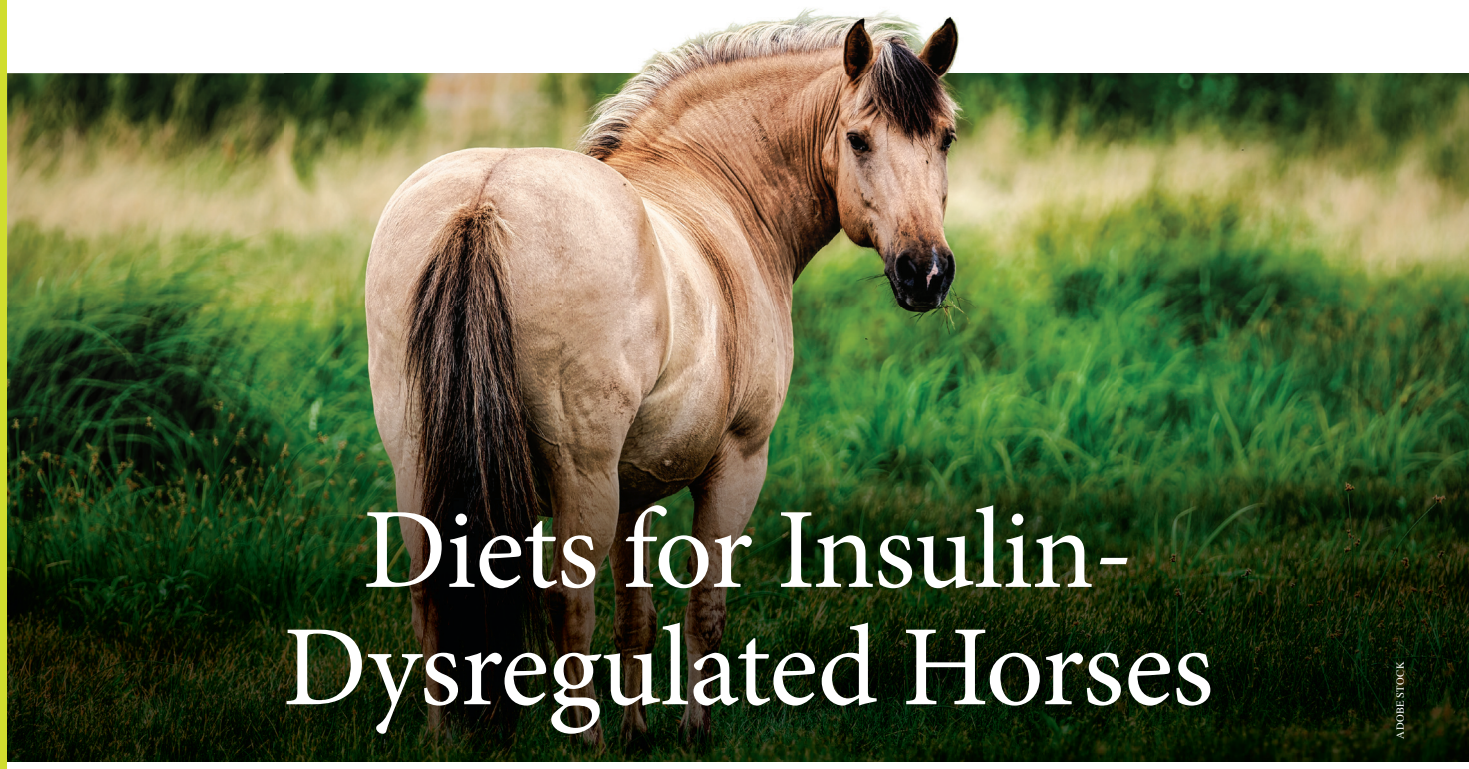
**Take-Home Message:** For mares in embryo transfer programs, optimizing micronutrient and fatty acid intake might be a practical strategy to support ovarian responsiveness and reproductive efficiency. However, larger studies are needed to confirm these findings and determine whether supplementation consistently improves embryo recovery rates.

*Camargo CE, Kozicki LE, Souza FA, de Lima PHL, Nogueira E. Long-term micronutrient and amino acid supplementation increases embryo recovery per flush and ovarian responsiveness in donor mares. J Equine Vet Sci. 2026 May;160:105844.*

## In Summary

Based on the collective research in this field over not only the past year but several decades, increasing evidence shows that nutritional strategies affect every aspect of equine health. By optimizing the equine diet, we might be able to address concerns related to obesity, respiratory health, athletic and reproductive performance, and a rich and diverse microbiome, among others. In addition to providing a balanced, high-quality diet, such strategies might include decreasing starch, offering quality nutritional supplements, and exploring supplemental fatty acids. EM

**Sentinel's equine nutrition team is available to help you and your practice make dietary recommendations, educate clients, and provide your patients with quality nutrition. Submit your nutrition questions and get expert advice at KentFeeds.com/vet-hub.**



# Diets for Insulin-Dysregulated Horses

ADOBE STOCK

What we're learning about ID horses and their insulin responses to various feeds and nutrients.

By Nancy S. Loving, DVM

Diet is a cornerstone of managing insulin dysregulation (ID) in horses, but individual animals can respond differently to specific feeds and nutrients. Recent research is helping clarify how ID horses respond to different dietary components, offering equine veterinarians more insight into nutrition plans for these horses.

## Nutraceutical to Mitigate Insulin Resistance

A collaborative study from the University of Kentucky and Utrecht University in the Netherlands assessed whether supplementation with a nutraceutical containing omega-3 fatty acids, glutamine, vitamin E, and active brewer's yeast could mitigate insulin resistance in horses with a history of or predisposition to insulin dysregulation.

During the four-week study, eight horses received a pelleted proprietary nutraceutical along with a high-starch diet and ad libitum low-NSC grass hay. Eight control horses received a pellet without nutraceutical ingredients. The researchers performed a combined glucose-insulin tolerance test (CGIT) on all 16 horses prior to and four weeks after the trial.

None of the study horses experienced a laminitic episode during the four weeks of high-starch feed consumption. Insulin sensitivity parameters did not change from baseline for horses receiving the nutraceutical, suggesting it might have a protective effect. Treatment did not alter basal insulin concentrations compared to the placebo. The CGIT testing at 75 minutes showed insulin concentrations of 30 uIU/ml for the treated group compared to 50 uIU/ml for the placebo group. While both groups showed insulin resistance, the nutraceutical-treated group had the same insulin concentrations at the start and end of the trial while the placebo group showed elevations above baseline at the end of the trial. In addition, the glucose clearance time in supplemented horses was 32 minutes compared to 54 minutes for the placebo group. Supplemented horses cleared blood glucose from circulation 61% faster than the placebo group.

The study authors said the nutraceutical's possible mechanisms of action to increase insulin sensitivity might be attributed to:

- Omega-3 fatty acid modulation of fat metabolism and reduction in systemic inflammation.

- Glutamine increases insulin sensitivity in muscle and normalizes hepatic glucose production while reducing adiposity and glucose uptake by adipose tissue.
- Vitamin E antioxidant properties reduce fasting insulin and insulin sensitivity in humans.
- Brewer's yeast is a bioactive source of chromium that increases insulin receptor activation.

**Take-Home Message**: Treatment with a pelleted proprietary nutraceutical in ID-prone horses might help reduce their risk of laminitis development from prolonged hyperinsulinemia.

*Loos C, Castelein A, Vanzant E, Adam E, McLeod KR. Nutraceutical Supplement Mitigates Insulin Resistance in Horses with a History of Insulin Dysregulation During a Challenge with a High-Starch Diet. Animals (Basel). 2024 Nov 25;14(23):3385*

## ID Horses' Insulinemic Responses to Varying NSC Levels and Meal Sizes

To determine if nonstructural carbohydrate content coupled with meal size or NSC in the meal results in augmented insulin responses in insulin-dysregulated horses, a British and Kentucky collaborative study compared seven ID and eight NID (non-insulin-dysregulated) horses fed different feeds with varying levels of NSC.

In the first phase (March through May 2023), two pelleted feeds at 6.8% and 14.6% NSC and one sweet-textured feed at 35.5% NSC were fed at three different NSC intake levels for a total of nine treatment diets. Each horse received each diet once in a randomized crossover design with a two-day washout period in between. The second phase (June through July 2024) evaluated the effects of high-NSC pelleted feed in four ID and four NID horses.

In both trial phases, ID horses experienced an augmented postprandial insulinemic response (APIR) to small pelleted meals above 0.11-0.12 g NSC/kg BW regardless of the feed's NSC percentage. In contrast, NID horses did not experience an APIR to either NSC content or meal size. Further, the diet's total NSC appears to be the predominant driver of postprandial insulin responses rather than crude protein content.

**Take-Home Message:** The authors concluded that the same feeding protocols for ID and NID horses might not be appropriate due to varying insulin responses. When feeding ID animals, they stress the importance of individual monitoring and focusing on meal size and amount of NSC per meal rather than just the percentage of NSC.

*Kerley BS, Harris P, Jacquay E, Askins M, McClendon M, Adams AA. Identifying insulinemic responses of ID horses offered varying levels of NSC and meal-sizes. J Equine Vet Sci. 2025 Aug;151:105638*

## ID Horse's Metabolic Response to Forage Pellets

In another collaborative study, researchers examined the metabolic responses of both ID and NID horses to forage pellets with low nonstructural carbohydrate content (< 10% NSC) compared to high NSC and low NSC (control) content feedstuffs.

Fifteen horses were split into two groups: 8 ID and 7 NID horses, none of them with concurrent PPID. The study was completed over six weeks in autumn using five different dietary treatments: Three horses received the same treatment each day with each metabolic group represented. The horses consumed small intakes (1 g/kg body weight, about 16 ounces for a 1,000-pound horse) of different forage pellets offered randomly so each horse recevied each dietary treatment on one occasion. All five diets were represented each week of the collection period, with a 7-day washout period between changing dietary formulations and weekly blood collections. The team pulled blood after complete pellet consumption at 60, 90, and 120 minutes and analyzed it for glucagon-like peptide-1 (GLP-1) and insulin.

The following five pellet/feed options were fed according to a randomized crossover design, in addition to ad libitum low-NSC grass hay:

- A positive control of oat groats (OG).
- A negative control of low-NSC pellets (LNSC) containing soybean hulls, dried beet pulp, dehydrated alfalfa meal, and soybean oil.
- Timothy hay pellets (TH).
- Alfalfa hay pellets (AH).
- Timothy/alfalfa hay pellets (TAH).

Based on their results, the researchers found that:

- Peak insulin was higher for ID and NID horses fed OG than for all other diets.
- Peak insulin for NID horses was higher for OG and TAH compared to LNSC, TH, and AH.
- ID horse insulin was higher than NID horses with corresponding diets.
- For ID horses, insulin for LNSC did not differ from any forage pellet, nor was it different from NID peak insulin responses for TAH or OG.
- Incretin (iGLP-1) did not differ relative to time, treatment, diet, or interaction of time and treatment diet for NID or ID or between NID vs. ID horses.

**Take-Home Message:** "Overall, NID and ID horses differ in postprandial insulin responses to certain forage pellets and even the control pellet that is less than 10% NSC," the authors stated. They suggested that forage pellets fed at low intakes of 1 g/kg body weight could be a "relatively safe feedstuff" for ID horses.

In future validating studies, the authors recommended increasing meal size and number of study horses and evaluating ID horses' glycemic and insulinemic responses when fed long-stem forage. EM

*Macon EL, Harris P, McClendon M, et al. Insulin dysregulated horses metabolic responses to forage pellets. J Equine Vet Sci 2024, v. 133*




# Feeding Horses With Asthma

The latest on supplements, steaming, soaking, and preservatives for managing SEA.

By Stacey Oke, DVM, MSc

Nutritionists in human and veterinary medicine are increasingly focusing on how nutrition can be used to benefit horses by both preventing and treating disease. One prime example of this is with equine asthma management. Always a prolific area of active research, studies published over the past several years have identified various ways of manipulating the equine diet to maximize respiratory health in the asthma setting.

## Fish Oil Decreases Airway Inflammation Without Dust Control

In a study presented at the 2025 AAEP Convention, Laurent Couëtil, DVM, PhD, DACVIM, and colleagues found that supplementing the diets of Thoroughbred racehorses with omega-3 fatty acids once daily for four weeks reduced airway inflammation. Specifically, they identified a significant decrease in neutrophils in bronchoalveolar fluid collected at baseline and after four weeks of supplementation. Additionally, performance improved remarkably: Supplemented horse money earned increased from $181.07 to $2,163.37, while control horse money earned decreased from $907.47 to $66.91.

Couëtil pointed out that these observed benefits of fish oil occurred in the absence of other disease-mitigating strategies, including dust control.

## Studies on Storing, Soaking, and Steaming Hay

Hay and bedding are leading sources of respirable particles, airborne microorganisms, organic debris, and fungal spores

that can irritate the respiratory tract, exacerbating equine asthma. Kocher et al. relayed that concentrations of fungal spores can reach up to 1.6 x $10^9$ spores/$m^3$ of air during hay handling. They also reported that even drying methods of hay can affect airborne dust and microorganisms and, therefore, air quality.

In that study, the researchers evaluated two populations of hay from either intensively managed (grass hay characterized by regular fertilization and a higher cutting frequency) or extensively managed (more diverse plant species, no fertilization, and only 2-3 cuts per year) grasslands. Particulate matter smaller than 2.5 microns ($PM_{2.5}$), a size anticipated to reach the lower airways when inhaled, was measured in 18 hay samples. $PM_{2.5}$ was lowest in barn-dried intensively sourced hay and highest in extensively sourced hay. Microbial load was also highest in hay from extensively managed grassland. Thus, forage processing, handing, and storage are all relevant to equine respiratory health and welfare.

While steaming and soaking are generally touted as appropriate means of addressing dusty hay, Raïsky et al. noted conflicting results in the literature. To gain clarification, they performed a crossover study in which they offered nine adult horses diagnosed with severe equine asthma in remission either dried or steamed hay fed off the ground for four weeks. They recorded lung resistance, clinical scores, bronchoalveolar lavage fluid cytology, tracheal mucous scores, and post-bronchodilation lung functions at baseline and following the four-week diet trial. Lung function and airway inflammation worsened significantly in horses fed dry or steamed hay without any accompanying deterioration of clinical scores.

"In that study, steamed hay induced deterioration in lung function in asthmatic horses in remission," noted co-author Mathilde Leclère, DVM, DACVIM, PhD. "It is noteworthy, however, that exacerbation of SEA was only unexpectedly mild and may have contributed to the lack of observable differences between the dried and steamed hay management."

Steaming hay is often the preferred method of decreasing particulate matter compared to soaking, because it results in less leaching of nutrients and less bacterial growth. However, researchers have shown that soaking does effectively reduce airborne particulate matter.

In that study, Ivester et al. used a real-time wearable PM monitor fixed to the halters of 10 horses to compare $PM_{10}$ and $PM_{2.5}$ while horses were fed either soaked or dry hay. For soaking, flakes were completely submerged for 15 minutes to saturate the hay without changing the nutritional quality. PM was measured every five seconds for eight hours.

Soaking the hay significantly reduced both mean $PM_{2.5}$ and $PM_{10}$ exposure. While no lung function tests were performed in this study, when combined with previous study results reporting that soaking does improve lung function in horses with severe equine asthma (Westerfeld et al. 2023), Ivester et al. suggest, "soaking hay provides a suitable method to decrease PM exposure to minimize airway inflammation."

The researchers also noted that these personal, affordable PM monitors might be useful for owners and veterinarians when assessing the breathing zones of individual horses to optimize respiratory health in an at-home setting.

**Take-Home Message:** Forage production, management, and storage can influence respiratory health, while soaking and steaming hay can reduce particulate exposure in horses with asthma.

*Kocher J, et al. Airborne dust and microorganisms from hay produced on intensively and extensively managed grasslands in Switzerland. Vet Anim Sci. 2026 May 20;33:100706.*

*Raïsky C, et al. Steamed hay for the prevention of severe equine asthma exacerbations. Equine Vet J. 2026 Jul;58(4):1127-1134.*

*Ivester KM, et al. A wearable real-time particulate monitor demonstrates that soaking hay reduces dust exposure. Equine Vet J. 2025 Jul;57(4):1065-1073.*

## Proprionic Acid to Reduce Mold Counts in Hay

Taking yet another approach at managing equine asthma, Leduc et al. evaluated propionic acid's effects on fungal growth in hay and airway inflammation and presented their findings at the 2026 ACVIM Forum. Propionic acid is commonly used as a preservative in animal feeds and grains, as well as baked goods, cheese, and other processed human foods to prevent mold and bacterial growth. The researchers sampled hay that had and had not been baled with propionic acid the previous year for fungal growth and fed it to horses diagnosed with severe equine asthma for four weeks. As expected, mold counts were lower in hay preserved with propionic acid. Further, lung resistance did not increase (worsen) in horses when fed preserved hay, but it did increase when horses were fed untreated hay. Similarly, bronchoalveolar lavage fluid neutrophil counts increased in horses fed unpreserved but not preserved hay.

**Take-Home Message:** "Propionic acid reduced molds in hay baled at high moisture content. Feeding [propionic acid-treated hay] may attenuate, but not completely prevent, exacerbations of severe equine asthma," the authors stated.

## In Summary

Mild-to-moderate asthma occurs in up to 70% of horses, and approximately 14% of horses suffer from SEA. This disease is considered a welfare issue because of the associated physical tolls, performance limitations, and reduced quality of life. While medications can help manage it, alternate strategies are needed, including the dietary ones discussed herein: dust mitigation by soaking/steaming hay to reduce respirable airborne particles, nutritional supplements to support respiratory health and decrease airway inflammation, and potentially hay preservatives. EM



# The Effects of Mare Nutrition on Offspring

ADOBE STOCK

Study findings continue to shed light on how maternal nutrition affects foal development.

By Nancy S. Loving, DVM

The mare's nutritional status during pregnancy can have lasting effects on her foal, potentially influencing growth, metabolism, and long-term health. Recent research is shedding light on how maternal nutrition affects fetal development, offering equine veterinarians important considerations for feeding and managing broodmares.

## The Effects of Maternal Obesity

Researchers in France and Belgium confirmed that obesity-related inflammation of the mare during pregnancy can have lasting effects on the foal. Robles et al. evaluated offspring growth, metabolism, low-grade inflammation, testicular maturation, and osteochondrosis lesions in 24 foals until they reached 18 months of age. In the study, 24 mares artificially inseminated by the same stallion were separated into two groups by body condition score (BCS). Ten mares had a BCS < 4 (normal BCS on the 1-5 scale applied to this study), and 14 mares had a BCS > 4.25 (overweight).

During gestation, obese mares had high serum amyloid A (SAA, a marker of inflammation) and leptin concentrations and lower plasma urea and adiponectin than normal mares. The researchers evaluated mare BCS each month following insemination until weaning. Obese mares suffered more insulin resistance and more low-grade inflammation in late gestation than normal mares.

Following birth, the team measured foal weight, size, BCS, plasma SAA, leptin, adiponectin, T3 and T4, and corticosteroid administration regularly until 18 months old. Offspring growth until six months of age did not differ between groups, but foals from obese mares had increased plasma SAA concentrations from 3-6 months of age and were more insulin resistant from 6-18 months of age than foals from mares with normal BCS.

Importantly, foals born to obese mares had a greater incidence of osteochondrosis than foals from normal mares. Between 6-12 months of age, osteochondrosis lesions did not differ between groups. At 12 months, all yearlings were brought inside during winter and fed twice-daily carbohydrate-rich concentrates. More (7

of 13) yearlings from obese mares developed osteochondrosis lesions than foals (1 of 10) from the normal-BCS mares.

"In vitro, insulin stimulates the differentiation of preosteoblasts into osteoblasts as well as chondrocyte survival and proliferation and cartilaginous growth," the authors wrote, adding that low-grade inflammation might also inhibit bone growth.

"Maternal obesity altered metabolism and increased low-grade inflammation in both dams and foals," they concluded. "The risk of developing osteochondrosis at 12 months of age was also higher in foals born to obese dams."

**Take-Home Message:** Both obesity and undernutrition can have deleterious effects on offspring during pregnancy. For equine practitioners managing broodmares, the goal is to have mares at an optimal body condition score prior to insemination and to maintain optimal body condition throughout pregnancy and lactation.

*Robles M, et al. Maternal obesity increases insulin resistance, low-grade inflammation and osteochondrosis lesions in foals and yearlings until 18 months of age. PLoS ONE 2018, 13(1): e0190309.*

## Mare Supplementation With Branched-Chain Amino Acids

A mare's nutritional status has a direct effect on milk production and composition, both important to the growth and health of suckling foals. In 2025, researchers in China evaluated the use of branched-chain amino acids (BCAA) fed at different doses to 20 mare-foal pairs.

In the study, three groups of five mares with foals 2-3 months old were fed either low dose (38 g/day), medium dose (76 g/day), or high dose (114 g/day) BCAA containing leucine, isoleucine, and valine. A fourth group of five mares with foals served as controls. The objective was to increase milk yield and composition to support foal development.

The researchers added the BCAA supplement to 4.5 pounds of concentrate for 60 days, plus a seven-day adaptation period. The mares were separated from the foals to eat concentrate and supplement, and on Days 0, 15, 30, 45, and 60 they were milked four times a day to evaluate milk yield and composition. On Days 0 and 60, the foals were fasted for two hours and then had blood samples taken. On Day 60, foal fecal samples were obtained.

The results show that BCAA supplementation can enhance milk fat yield and increase growth hormone and progesterone in the mare's milk, with growth hormone increases at dose-dependent rates of BCAA supplementation. The medium dose of 76 g/day was effective, but the high dose (114 g/day) had the strongest effects on organic acid abundance and influences on lipid, energy, and BCAA metabolism.

The authors concluded that the medium dose of 76 g/day "supported growth without metabolic stress." The high-dose supplementation was associated with increased blood urea nitrogen, indicating higher nitrogen load.

"BCAA supplementation regulates milk fat synthesis and promotes foal growth via a milk-microbiota-metabolism axis, providing a basis for improving milk quality and offspring development through maternal nutrition," they reported.

**Take-Home Message:** BCAA supplementation might offer a nutritional strategy for influencing milk composition and supporting foal growth, but more evidence is needed to recommend supplementation as standard practice. For veterinarians, ensuring lactating mares receive a balanced diet that meets their protein and amino acid requirements remains the priority.

*Meng C, et al. BCAA supplementation enhances milk fat synthesis in Yili mares and promotes foal growth through remodeling of intestinal amino acid metabolism. Front Microbiol 2025, Nov 6;16*

## Supplementation to Improve Mare and Foal IgG Levels

Researchers in Brazil evaluated whether supplementation with *Saccharomyces cerevisiae* or β-glucan in late gestation could improve total IgG colostral concentration.

The study involved 21 mares: seven in a control group supplemented with saline, seven given a yeast supplement of oral *S. cerevisiae*, and seven given oral β-glucan from 300 days of pregnancy until delivery. Colostrum and serum were collected immediately following birth, and foal blood was collected 12 hours later to evaluate for IgG concentrations.

Mares supplemented with β-glucan had significantly higher IgG concentrations in colostrum compared to controls, but this did not increase serum IgG in the foals. While *S. cerevisiae* supplementation did not appear to significantly increase total IgG in mare colostrum, foals born to *S. cerevisiae*-supplemented mares had higher serum IgG concentrations compared to controls.

The authors concluded, "This study provides evidence that manipulation of the mares' diets in late gestation to add β-glucan increased the IgG concentration in their colostrum. The addition of *S. cerevisiae* appears to improve the concentration of IgG in their foals within 12 hours after birth."

**Take-Home Message:** Late-gestation supplementation with β-glucan or *S. cerevisiae* might influence passive transfer of immunity, but these supplements should not be considered replacements for timely assessment of colostrum quality and foal IgG after birth. EM

*Sobral GG, et al. Effect of Supplementation with Saccharomyces cerevisiae and β-glucan to Mares During Late Gestation on Colostrum Quality and Passive Transfer of Immunity in Foals. J Equine Vet Sci. 2023 Feb;121*

**Ideal for pregnant mares in late gestation, Sentinel Grow & Excel is a high-fat, high-fiber, low-starch, and low-sugar extruded feed designed to support health and performance through every life stage.**





# Understanding NSC Levels

ADOBE STOCK

## The latest study findings on NSC variability in hay and pasture and the importance of forage testing.

By Alexandra Beckstett

Nonstructural carbohydrate (NSC) levels in forage can vary considerably, even among the same hay and pasture sources. For equine veterinarians managing patients with metabolic disease, insulin dysregulation, or other conditions requiring dietary NSC restriction, understanding that variability is essential to making informed nutritional recommendations. New research examining NSC variability in hay and pasture underscores the importance of forage testing and provides valuable context for interpreting NSC results in clinical practice.

### Pasture NSC Varies by Day, Time

Restricting pasture access to early morning hours is commonly recommended for insulin-dysregulated (ID) horses, particularly as cool-season grasses mature beyond their initial spring flush. However, pasture NSC concentrations can change throughout the day and from one day to the next, potentially affecting at-risk horses' insulin response.

In a recent study, a team of researchers from the University of Kentucky, Lincoln Memorial University, and the Waltham Petcare Science Institute's Equine Studies Group evaluated these changes in early summer and examined whether fluctuations in pasture NSC were reflected in circulating insulin concentrations.

They studied seven adult ID horses grazing the same Kentucky cool-season grass paddock in June 2024. During the first phase, pasture samples and blood samples were collected each morning between 8 and 9 a.m. for five consecutive days. In the second phase, samples were collected from the same horses and paddock at 8 a.m. and 3 p.m. on the same day. Pasture NSC was measured using near-infrared spectroscopy, and serum insulin concentrations were evaluated alongside environmental temperatures.

Morning pasture NSC declined over the five-day period, from 15.3% to 10.1% dry matter. Although the researchers found no correlation between daily temperature and NSC, the decrease in pasture NSC was accompanied by a significant decline in horses' blood insulin levels. Mean insulin concentrations were approximately 217 µIU/mL on the first day, compared with 129 µIU/mL on Day 4 and 124 µIU/mL on Day 5.

The second phase demonstrated that the commonly recommended morning grazing window does not necessarily guarantee low-NSC pasture. Both temperature and NSC increased from morning to afternoon, with pasture NSC rising from 9.5% DM at 8 a.m. to 13.4% at 3 p.m. Serum insulin increased concurrently, from a mean of 78 to 101 µIU/mL. The team noted considerable individual variations in insulin responses, even among horses grazing the same pasture.

**Take-Home Message:** Early-morning turnout might reduce NSC exposure compared with afternoon grazing, but it should not be considered a guarantee of safe pasture for high-risk ID horses. Pasture testing can help identify these fluctuations, but because individual insulin responses can vary significantly, veterinarians should consider ongoing monitoring of both pasture conditions and the horse's metabolic response when making grazing recommendations.

*Askins M, Harris P, Palmieri G, Gregory A, McClendon M, Adams A. Effect of day and time on pasture nonstructural carbohydrates and insulin in horses with insulin dysregulation. 2025 6th Global Equine Endocrine Symposium proceedings #5 p10.*

## Storage and Handling Can Affect Forage Nutrient Levels

For veterinarians managing ID horses, accurate forage analysis is essential for ensuring low-NSC diets. But fresh forage is biologically active after collection, and its nutrient composition can change depending on how the sample is handled before laboratory analysis. In a recent study, researchers evaluated whether different storage conditions and durations affect nutrient levels in fresh forage, with particular attention to NSCs.

The team collected samples from a mixed-grass pasture and a ryegrass plot and compared five storage-handling methods: microwave oven followed by freezing at -20°C, room temperature (20°C), refrigeration at 3°C, freezing at -20°C, and freezing at -80°C. Samples were analyzed after either 24 hours or one week of storage for crude protein (CP), water-soluble carbohydrates (WSC), ethanol-soluble carbohydrates (ESC), starch, and NSC, defined as starch plus WSC.

Storage conditions and duration affected several nutrient measurements. In the mixed-grass forage, samples stored at room temperature showed significant decreases in WSC, ESC, and NSC after one week compared with 24-hour samples. ESC and starch also decreased in ryegrass stored at -80°C for one week, while CP decreased in the mixed-grass forage under the same conditions. Conversely, some nutrients increased over time under particular storage conditions. CP in ryegrass increased in samples stored at -20°C, while ESC in mixed grass increased following microwave treatment.

The findings demonstrate that fresh forage can undergo metabolic changes after sampling, potentially altering lab results. Importantly, the effects were not consistent across nutrients or storage methods, highlighting that simply freezing a sample does not necessarily preserve its original nutrient profile.

**Take-Home Message:** Sample handling before forage analysis for ID horses matters. Ideally, fresh forage should be analyzed as soon as possible. If immediate analysis is not feasible, the researchers recommend transporting the sample on ice after collection, refrigerating it promptly, and keeping it refrigerated for no more than one week before shipping on ice to the laboratory.

*Kerley BS, Harris P, Lea K, McClendon M, Adams AA. Effects of storage-handling methods on nutrient analysis of fresh forage samples. J Equine Vet Sci. 2024 Nov;142:105182.*

## Horse Owners Might Have Gaps in Their Understanding of Pasture NSC

Environmental conditions can cause variations in pasture grasses' NSC content, making it important to understand these factors when managing horses at risk for conditions associated with high sugar intake. Researchers at the University of Lincoln, in the U.K., examined how well horse owners understood the factors that influence pasture sugar content and whether more horse experience was associated with more accurate knowledge.

The researchers surveyed 194 people who owned or cared for horses, most of whom were based in the United Kingdom. Nearly 90% reported managing a horse with a condition potentially affected by pasture, most commonly laminitis, equine metabolic syndrome, or seasonal weight gain. Despite this experience, participants demonstrated significant gaps in their understanding of factors that influence grass NSC concentrations.

Participants were asked about nine environmental factors known to affect grass sugar concentrations, including temperature, sunlight, rainfall, drought, frost, overgrazing, rotational stocking, and fungal presence. Frost was the factor most commonly identified as affecting sugar levels, followed by sunlight and overgrazing or stressed grass. However, only 12% of participants correctly identified rotational stocking as a factor that can influence sugar concentration, while 74% said they did not know whether fungi affect grass sugar levels. Participants also had difficulty identifying the time of day when grass sugar concentrations are typically highest: Only 34% selected afternoon, with another 14% selecting evening. Research indicates that NSC generally peaks after midday or in the late afternoon during the growing season.

Previous experience with horses was not significantly associated with more accurate responses. The researchers also found that only 6.2% of respondents had tested their pasture to measure sugar content, suggesting that management decisions are often being made without accurate information about pasture NSC.

**Take-Home Message:** Don't assume owners understand how pasture management and environmental conditions affect NSC simply because they have extensive horse experience. Veterinarians can play an important role in translating the science into practical grazing recommendations and encouraging pasture testing rather than relying on assumptions about when or where grass will have a lower NSC concentration. EM

*Moaby, I., A. Aitken, and S. Varga. 2026. Scientific Evidence and Common Perceptions of Factors Affecting Sugar Content in Pasture Grass: Is There a Link With Pre-existing Horse-Related Experience? Veterinary Medicine and Science 12, no. 1: e70778.*

**Do you have clients with 5 or more horses in their barn? Connect them with Sentinel Feed's nutrition team for complimentary forage testing to help optimize their horses' nutrition.**



# A Senior Horse Still Up for the Next Challenge

## How thoughtful nutrition can help older horses keep doing what they love

At 20 years old, Talia still has places to go.

Over the years, the eventing horse and her owner, Kate Allonardo, have tackled bigger shows, moved up levels and taken on plenty of adventures together. And while Talia has mellowed somewhat from the intense, opinionated, 6-year-old horse Kate first brought home, one thing hasn't changed: She is still game for whatever comes next.

But keeping an older horse ready for that next challenge can require a different approach to nutrition.

As horses age, they may become less efficient at digesting and absorbing certain nutrients. Dental changes can make chewing more difficult, while maintaining weight, muscle and topline can be more challenging. Kate began noticing some of those age-related changes in Talia's overall condition and appearance.

For Talia, Sentinel® Performance LS, a low-starch, extruded horse feed, became part of the answer.

**Supporting senior horses with low-starch, extruded nutrition.**




Lower starch and sugar levels can be beneficial for supporting digestive health. By helping shift the digestion of starch and sugar to the stomach and small intestine, less reaches the hindgut, which helps support the delicate microbial population that plays an important role in a horse's overall health.

The extrusion process provides several advantages for horses. It takes finely ground ingredients and pressure cooks them with moisture to create light, airy nuggets. This allows the feed to break down more easily, even with the horse's first bite, making nutrients like protein, sugar and starch more available for digestion and absorption.



The feed's physical form can be particularly beneficial for senior horses. Sentinel's extruded nuggets are larger, lighter and more voluminous than traditional pellets, requiring less effort to chew while encouraging horses to eat more slowly.

For horses experiencing dental challenges or those with a history of choke, extruded feed can also be soaked into a soft mash in a matter of minutes. This provides another feeding option for horses that may struggle with chewing while supporting digestion. According to Sentinel Equine Research and Nutrition Specialist, Dr. Randel Raub, PhD, "We have seen that Sentinel's extruded form results in more jaw movement per pound of feed consumed. This encourages saliva production, which helps buffer the stomach."

For Talia, those nutritional benefits support something much bigger: her ability to keep doing what she loves.

After switching to Sentinel Performance LS, Kate noticed improvements in Talia's overall condition. Maintaining weight became easier, her back and topline looked better and even the dapples Kate hadn't seen in years returned.

Today, Talia continues to compete. But for Kate, success isn't simply another ribbon or level achieved. It's having a happy, healthy senior horse who still wants to go along for the ride.

Because getting older doesn't have to mean giving up the next challenge. With thoughtful management, appropriate exercise and nutrition that supports changing needs, senior horses like Talia can continue doing more of what they love.

The Sentinel team can help you make the best nutritional decisions for your horse and the horses in your care. Sign up for the latest news, research and expert nutritional guidance for all horses.

Sentinel



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# Creative Feeding Strategies for Challenging Horses

Two case studies illustrate how creative, practical feeding strategies can meet individual horses' nutritional needs while supporting their overall well-being.

By Madeline Boast, MSc. Equine Nutrition, PAS

Nutrition is a key pillar of equine management and well-being. Effectively managing a horse's diet must not only take their nutrient requirements into account but also be practical for management. The following case studies highlight some creative approaches to doing just that.

It is no secret that horses are living longer. With scientific developments in veterinary and nutrition technology, we can better support and care for our horses well into their senior years. Let's meet Tiny and learn about his nutrition journey.

## Case Study No. 1: Tiny

Tiny, a 34-year-old Quarter Horse, is a complicated case. Because of his age, his dentition is expired, meaning he can no longer chew and consume any long-stem fiber. Additionally, he has been diagnosed with kidney failure and tends to be quite picky.

The primary goals for Tiny's feeding program were to:

- Meet fiber intake requirements.
- Meet (but not oversupply) protein requirements with quality protein sources.
- Keep the ration palatable.

As an equine nutritionist, I have worked with Tiny for years, and his ration has evolved and changed with his taste preferences.

Tiny's balanced ration started with a combination of hay cubes, a fiber-based complete feed, and a senior feed, along with loose salt and an additional fat supplement to help with calorie intake. This sustained Tiny well; however, over time he became less keen on hay cubes, and we have also added more digestive support as he has aged.

Tiny now consumes a combination of hay pellets, a balanced hay cube (timothy and beet pulp), and the same senior feed, plus a performance fat/fiber-based pellet to add variety into some of his meals.

Because Tiny does not eat hay, his meal management is challenging. It is recommended that horses consume



COURTESY JUSTINA REINHART

**Tiny, pictured here on his 34th birthday, needs extra help getting enough calories to stay in good condition.**

1.5-2% of their body weight in forage (on a dry matter basis) daily. For an 1,100-pound horse, this would be about 20-22 pounds of dry hay per day.

When a horse does not eat hay, we must be conscious of fiber intake and safe meal sizes. It's critical to ensure the horse has ample chew time to prevent the development of stereotypic behaviors and has regular fiber moving through the gastrointestinal tract to prevent common health issues such as gastric ulceration.

In some cases, owners might opt to separate a horse that cannot consume hay and allow free-choice access to hay cubes or pellets. However, I encourage them to take a holistic approach and remember that horses thrive in a herd environment.

In an ideal world, we would divide Tiny's daily feed into six meals fed every four hours. This is simply not sustainable management for most owners, however, and if a program is not practical to implement, it's pointless.

Instead, Tiny receives three main meals, then gets two separate buckets overnight. One contains his senior feed, and the other his balanced hay cubes. This ensures he does not have any meals that are too large to be consumed safely in one sitting, while still meeting his fiber requirements and allowing daily turnout with herdmates.

Being flexible with management and getting creative when needed was important for building a program that worked for Tiny.

We are now going to switch gears, from a horse that needs help getting enough calories to one that needs calorie intake controlled closely. We'll continue to focus on forage first and chew time to ensure we are feeding our horses in a way that supports how they have evolved to thrive.

## Case Study No. 2: Piper

Piper, a 16-year-old mixed-breed mare, is my personal horse and one of the key reasons I pursued equine nutrition. If you have ever managed an "easy" keeper, which is a horse that gains and maintains weight easily, you will know how difficult it can be. Over the years, Piper has been at two different boarding facilities, and the optimal management looked different at both. At the first facility, Piper shared a paddock with another easy keeper. They were fed rationed hay, in combination with straw, in a slow feeder. The rationed hay was divided into four portions daily to be put into their slow feeder with straw.



COURTESY DOSWELL CREATIVE

**Piper eats hay out of a slow feeder and wears a grazing muzzle to control forage intake.**

The straw prolonged chew time, without the need for additional hay providing too many calories. This management worked well. However, Piper moved to a facility with only three equids, one of which was a harder keeper. Because horses need forage, friends, and freedom, the three equids were housed together, which posed new feeding challenges and a different puzzle to solve.

Instead of adding a specific allotment of hay, we now needed to provide it on a free-choice basis to ensure the harder keeper could eat as much as they wanted.

For this herd, the digestible energy (calorie) content of the hay became a very important consideration. Prior to purchasing hay, it was tested to ensure it was average- to low-calorie, as anything too rich would not work for the easy keepers.

The hay was kept in a slow feeder, but to further slow the easy keepers down without impacting the harder keeper's forage intake, Piper wears a grazing muzzle. This combination works well because she can live in the herd environment while maintaining a healthy body condition.

Of course, hay alone will not meet a horse's nutrient requirements, specifically their vitamin and mineral needs. Additionally, depending on hay quality, protein might need to be supplemented. Whenever possible, I recommend testing hay.

For Piper, hay testing revealed the protein levels to be low. To balance her ration, in combination with her low-calorie hay fed in a slow feeder and through a grazing muzzle, Piper receives a protein-fortified ration balancer and loose salt. This keeps her calorie intake within an optimal range while ensuring her nutrient requirements are being met, and she can continue to live in her herd environment.

For horses with unique nutrition management problems, we often need to get creative in how we meet their needs, while ensuring feeding strategies are practical for us to implement. These two case studies are very different but come back to the same principles of prioritizing forage, friends, and freedom when faced with feeding challenges. EM


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They thought I'd never be a show horse, but I showed them.
Cricket and Tracy
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Born with Dummy Foal Syndrome, Cricket couldn't nurse and get the nutrition she needed to survive. As hope was fading, she started picking at her mother's Sentinel feed. Thanks to the easily digestible extruded nuggets, Cricket was able to get the balanced nutrition she needed when she needed it most. Today, she is healthy, happy and competing in Futurity Shows.
KENT
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